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L7: Entry 6 of 6 File: USPT Dec 2, 1986

DOCUMENT-IDENTIFIER: US 4626068 A
TITLE: Photoactive coating for hardening optical fibers

US Patent No. (1):
4626068

Brief Summary Text (3):
Optical fibers finding substantial commercial use as optical data links in communication systems must necessarily be characterized by relatively low losses in optical transmissibility along the length of the fiber. To this end, considerable prior work has been done in the development of optical fibers having desirable combinations of refractive indices for the core and cladding characterized by transmission losses of less than 1 dB/m. The use of optical fibers as data links in certain environments, such as satellite systems, weapons or other military related equipment, certain medical diagnostic instrumentation, geological survey equipment, and the like may subject the fiber to the influence of ionizing nuclear radiation. Exposure to the ionizing radiation may temporarily or permanently disable the fiber optic core depending upon the radiation type, intensity and exposure time affecting the fiber optic core. Disablement of the core by the ionizing radiation is associated with the interaction of the radiation with impurities in the core material, certain of which impurities may be included to achieve the desirable refractive index for the core material. The interaction of the radiation with the impurities generates optical absorption sites which characteristically interfere with the transmissibility of the optical fiber. Substantial reduction of transmissibility may result under the influence of the ionizing radiation, although characteristically the core material may slowly recover some degree of transmissibility upon removal of the radiation. Shielding the fiber optics from the radiation using conventional materials is inappropriate in most cases because of the mass of material required for effective shielding.

Brief Summary Text (6):
The invention described herein provides a novel optical fiber configuration comprising a conventional optical fiber core, with a conventional cladding, which has an additional outer coating of phosphorescent or luminescent material, or a coating or sheath of a transparent material within which a suitable phosphor material is distributed. This outer coating or sheath material should have a refractive index equal to or less than the index of the cladding material. Upon exposure of the optical fiber structure of the present invention to ionizing radiation, the phosphor material will be stimulated by interaction with the radiation to emit light of a desirable ultraviolet or visible wavelength to bleach radiation-induced optical absorption centers in the core. The presence of the phosphor in the coating in close proximity to the fiber optic core and cladding layer along its entire length therefore provides a source of ultraviolet or visible light to bleach the core continuously during the exposure of the fiber to the radiation and during the short time immediately following the irradiation during which the phosphor continues to emit bleaching light with a characteristic decay time. An outer metallic coating may be applied to the structure to enhance internal reflections of the phosphorescent light.

Detailed Description Text (2):
Referring now to the accompanying drawing, the novel optical fiber structure 10 of the present invention may include a conventional optical fiber core 11 of any typical

silica, glass, or plastic composition conventionally used for a light-conducting fiber core. A cladding 12 may be disposed around the core in the manner shown schematically in the drawing and may comprise a suitable transparent silica, glass, or plastic material having a desirable index of refraction to define an optical waveguide in cooperation with core 11. Ordinarily, cladding 12 will comprise a material having a lower refractive index than that of the material comprising core 11. The core-cladding interface may be a distinct step-index junction or it may be a radially-graded index junction similar to any of the various conventional constructions presently used for fiber optics. The core 11-cladding 12 structure may be produced by any of the well known methods, such as drawing, conventionally used in the art for producing optical fibers.

Detailed Description Text (3):
To the outer surface of the fiber optic core 11 and cladding 12 is applied the novel coating 13 of the present invention comprising a phosphorescent or luminescent material. Coating 13 may be in the form of a sheath applied to the outer surface of the cladding by conventional means such as by drawing, and may be of any desirable thickness consistent with size or weight limitations placed on the fiber assembly 10. Coating 13 may preferably comprise a suitable transparent material, such as clear plastic or glass, having distributed therethrough suitable phosphorescent or luminescent material such as depicted in the drawing as phosphor 14. Alternatively, coating 13 may comprise a clear lacquer or the like containing phosphor 14 applied conventionally to cladding 12. Coating 13 should preferably have a refractive index equal to or less than the index of the cladding material 12. Suitable high intensity phosphors 14 which emit radiation in the desirable wavelengths upon interaction with ionizing nuclear radiation and which may be appropriate for use herein include silver-doped zinc sulfide, manganese-doped magnesium silicate, and chromium-oxide-doped ruby. Many other phosphorescent or luminescent materials may be used as might occur to one with skill in the applicable art, and, therefore, it is understood that the named materials shall not be limiting of the present invention. Additionally, two or more optical fiber waveguides may be enclosed in one all encompassing photoactive coating if desired.

CLAIMS:

1. An optical fiber structure which is hardened against the effects of ionizing nuclear radiation emanating from a source external of said fiber structure, which comprises:

a. a light conducting core comprising a material having a first predetermined index of refraction;

b. a transparent cladding on said core, said cladding comprising a material having a second predetermined index of refraction less than said first predetermined index of refraction;

c. a substantially transparent coating on said cladding, said coating including a phosphorescent material substantially uniformly distributed throughout said coating for interacting with said ionizing radiation to emit light to irradiate that portion of said core near said light emitting phosphorescent material affected by said radiation; and

d. a metallized layer on said coating, said metallized layer including an internally reflective surface for reflecting said light into said core.

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L8: Entry 1 of 1 File: USPT Sep 23, 1997

DOCUMENT-IDENTIFIER: US 5669692 A
TITLE: Fiber optic lighting system

US Patent No. (1):
5669692

Brief Summary Text (6):
Another recent attempt to achieve uniform illumination for lighting purposes involves the use of optical fibers. As is known, an optical fiber consists of a core having a high refractive index and cladding covering the core which has a lower index of refraction than the core itself. Also, to make the optical fiber stronger and to prevent damage to the cladding, it is common to cover the cladding with a jacket which is usually some type of plastic material. Light rays are introduced into the core of the optical fiber. Since the index of refraction for the cladding is lower than the index of refraction for the core, light rays are generally kept inside the core. However, by bending or otherwise manipulating the optical fiber, it is possible to make light rays pass through into the cladding and escape from the optical fiber. This phenomenon will be described further in connection with the description of the preferred embodiment of the present invention below. An example of a fiber-optic lighting system is Lumitex Inc.'s "Fiber Optic Backlight". The Fiber Optic Backlight comprises acrylic optical fibers woven together to form a light-emitting panel. The panel is connected to a light source. As the light passes through the panel, computer-controlled "micro-bends" cause the transmitted light to exceed the critical angle of the fibers' core-cladding interface (the concept of the critical angle will be described below). This permits the light to leave the optical fibers without physical interruption of the cladding surface.

Detailed Description Text (3):
where n.sub.2 is the refractive index of the cladding and n.sub.I is the refractive index of the core. Let's assume for purposes of an example that n.sub.2 =1 and n.sub.1 =1.5. This means that .theta..sub.C =41.8.degree.. If the angle of incidence .theta. is less than the critical angle .theta..sub.C (41.8.degree. in this case), then light ray 26 will pass through the core 22 into the cladding 24, as shown by arrow 28. If the angle of incidence .theta. is equal to or greater than the critical angle .theta..sub.C, then light ray 26 will remain within the core 22, as shown by arrow 29. Note that light ray 28 which passes through the core 22 into the cladding 24 may pass outward into space, depending upon the angle at which the ray 28 strikes the interface between the cladding 24 and space.

Detailed Description Text (6):
As light rays travel through the core 22 of the optical fiber 21 which is wound in a spiral shape, some of the light rays will pass through the core-cladding interface and escape from the optical fiber 21. This is because the bending of the optical fiber 21 causes some light rays to be incident at the core-cladding interface at angles which are less than the critical angle .theta..sub.C. FIG. 4 illustrates this effect for a light ray 32 as it travels along the cut away portion of the optical fiber 21 between arrows IV--IV of FIGS. 3 and 3b. (FIG. 4 is a magnified top view of the cut away portion along arrows IV--IV of FIGS. 3 and 3b). Let's assume that the angle of incidence .theta. for light ray 32 is 55.degree.. If the index of refraction for the core 22 is 1.61 (typical for one kind of crown glass) and the index of refraction for the cladding 24 is 1.41 (typical for another kind of crown glass), then the critical

angle .theta..sub.C is 61.1. Since the angle of incidence .theta. for light ray 32 is less than the critical angle, light ray 32 will pass through the core-cladding interface into the cladding 24, as shown by arrow 34. Note that had the optical fiber 21 not been bent, light ray 32 would have remained within the core 22 since the angle of incidence for light ray 32 would not have been less than the critical angle .theta..sub.C of 61.1.degree..

Detailed Description Text (7):
The closer the windings of the spiral-shaped optical fiber 21 are to the center of the spiral, the more bent become the turns of the spiral-shaped optical fiber 21. In other words, the spiraling turns of the optical fiber 21 are much sharper near the center than they are near the periphery. The sharper turns lead to proportionately more of the light rays incident at the core-cladding interface to pass through into the cladding. This is because a sharp turn vis-a-vis a less sharp turn causes more of the light rays incident at the core-cladding interface to have acute angles of incidence which are less than the critical angle .theta..sub.c. Notwithstanding the greater percentage of light rays escaping the optical fiber 21 near the center of the spiral than at the periphery, the illumination provided by such spiral-shaped optical fiber 21 can still be uniform. Uniform illumination is possible because there is a greater number of light rays in the core 22 of the optical fiber 21 at the periphery than near the center of the spiral due to the fact that the light coupling means 30 is coupled to the optical fiber 21 at the periphery of the spiral (see FIGS. 3 and 3b). Thus, by manipulating the appropriate variables (e.g., indices of refraction for the core 22 and the cladding 24), the number of light rays escaping the optical fiber 21 along a given length of the spiral can be made fairly equal. This way, uniform illumination is achieved.

CLAIMS:

1. A lighting system, which comprises:

an optical fiber comprising a core and cladding, where a refractive index of the core is higher than a refractive index of the cladding;

the optical fiber being wound in a spiral shape comprising a plurality of turns, where the spiral shape optical fiber has an outer end;

a light source;

means for focusing the light from the light source to the core at the outer end of the spiral shape optical fiber; and

a casing enclosing the spiral shape optical fiber along a periphery and a bottom, except for an aperture to permit the core at the outer end of the spiral shape optical fiber to receive light from the light source, the casing having a reflective inner surface.

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L11: Entry 6 of 6 File: USPT Apr 9, 1985

DOCUMENT-IDENTIFIER: US 4510555 A
TITLE: Ornamental lighting device

US Patent No. (1):
4510555

Detailed Description Text (6):
Mirrors may be mounted on those ends of the optical fibers 30.sub.1 -30.sub.n which are remote from the optical coupling 28, so that the light may be more effectively radiated from the opposite surfaces of the lighting device, or luminous screen, 10. For additionally effective radiation of the light, a light transmitting material whose refractive index is larger than that of the optical fibers may be deposited on the surfaces of the optical fibers or, alternatively, recesses or grooves may be formed in the surfaces of the optical fibers. Such configurations of light conducting elements have been proposed in various forms by the applicant.

Detailed Description Text (15):
Various modifications will become possible for those skilled in the art after receiving the teachings of the present disclosure without departing from the scope thereof. For example, the mirror surface discussed in conjunction with the embodiment of FIG. 4 is similarly applicable to the other embodiments and may even be provided with a suitable pattern thereon. To omit the fiber retainer members in any of the embodiments described, one or both of the light transmitting panels may be formed with grooves for receiving the optical fibers therein. However, in the case where the optical fibers are individually recessed for light radiation as previously mentioned, the grooves in the panels will cause the light to leak when engaged by the recessed optical fiber walls. Such leakage may be eliminated by designing the refractive index of the panels smaller than that of the optical fibers.

CLAIMS:

8. An ornamental lighting device as claimed in claim 7, in which the light diffusing means comprises a light diffusing material deposited on the optical fiber and having a refractive index which is larger than a refractive index of the optical fiber.